FIRST RECORD OF REVERSAL IN *PSEUDORHOMBUS ELEVATUS* (PARALICHTHYIDAE).

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ABSTRACT. - A dextral *Pseudorhombus elevatus* Ogilby, 1912 (Paralichthyidae) was found in a collection of 11 normal sinistral specimens from the Oman Sea. This dextral specimen, the only known specimen for this species, is almost an exact mirror image of normal specimens except for the intestinal loops and liver that are not reversed.

RÉSUMÉ. - Première mention d'une réversion chez *Pseudorhombus elevatus* (Paralichthyidae).

Un spécimen dextre de *Pseudorhombus elevatus* Ogilby, 1912 (Paralichthyidae) a été identifié parmi un groupe de 11 spécimens senestres et normaux provenant de la mer d'Oman. Ce spécimen dextre, le seul connu de cette espèce, est l'image miroir presque parfaite de spécimens normaux. Seuls le foie et les circonvolutions de l'intestin ne sont pas inversés.

Key-words. - Paralichthyidae, *Pseudorhombus elevatus*, ISW, Oman Sea, Reversal.

Adult flatfishes (Pleuronectiformes) have both eyes on the same side of the head. This ocular asymmetry is acquired fairly early in larval life when one eye of an initially symmetrical fish migrates across the top of the head. In most flatfish species, the eyes are predominantly on the left side or on the right side (Chapleau and Amaoka, 1998). However, in a few species, the eye will indiscriminately migrate to the right or left side of the head (= ambidirectional migration).

This ambidirectional migration is observed in all species belonging to the most plesiomorphic clade of the order (Chapleau, 1993), the Psettodidae (*Psettodes erumei* (Bloch & Schneider, 1801); *Psettodes belcheri* Bennett, 1831; *Psettodes bennetti* Steindachner, 1870) (Norman, 1934). Other species showing the same ambidirectionality include *Tephrinectes sinensis* (Lacepède, 1802) (Norman, 1934; Hoshino and Amaoka, 1998), the paralichthyid *Paralichthys californicus* (Ayres, 1859) (Ginsburg, 1952; Kramer *et al.*, 1995) and the pleuronectid *Platichthys stellatus* (Pallas, 1787) (Policansky, 1982). In *P. stellatus*, fish found along the coast of Japan are mostly sinistral while fish inhabiting the coast of California are equally divided into dextral or sinistral fish. Coastal areas between these two regions show a clinal pattern of distribution of right eyed and left eyed specimens (Policansky, 1982).

The remaining species of flatfishes are almost invariably sinistral or dextral although rare cases of reversal have been reported (Gudger, 1935; Amaoka, 1964; Dawson, 1964, 1966, 1971; Gartner, 1986). Recent accounts of reversal in flatfishes include the paralichthyid *Paralichthys orbignyanus* (Valenciennes, 1842) (Diaz de Astarloa, 1997), the cynoglossid *Symphurus vanmelleae* Chabanaud, 1952 (Munroe, 1996) and the pleuronectid *Limanda limanda* (Linnaeus, 1758) (Bruno and Fraser, 1988). In the paralichthyid genus *Pseudorhombus*, reversals have been reported in *P. pentophthalmus* Günther, 1862 (3 cases) from the Western Pacific (see Amaoka, 1964).

Even if the ocular orientation has limited phylogenetic value (see Hensley and Ahlstrom, 1984; Chapleau, 1993), the identification of flatfishes always begins by observing if they are dextral or sinistral. Consequently, it becomes important that cases of reversal be noted to prevent potential misidentifications.

Materials and methods

The measurements follow Norman (1934). The specimens examined were all captured during the International Indian Ocean Expedition on the vessel *Anton Bruun* and are deposited at the Academy of Natural Sciences in Philadelphia (ANSP). They are: ANSP 145370: 1 specimen (reversed) (103.4 mm SL), 20°30'N-70°54'E, Indian Ocean, 33 m (18 fms), 15 Nov. 1963, Cr. 4B, st. 204A; ANSP 145325: 11 spms (81.16-114.48 mm SL), idem; ANSP 153453: 1 spm (137.72 mm SL), 23°43'N-58°23'E, Indian Ocean, Arabian Sea, off Oman, 49 m (27 fms), 3 Dec. 1963, Cr. 4B, st. 269A; ANSP 153606: 10 spms (79.36-120.88 mm SL), 29°27'S-31°31'E, Indian Ocean, South Africa, Natal, off Durban, 25 Sept. 1964, Cr. 8, st. 394B; ANSP 145326: 1 spm (102.44 mm SL) 23°16N-23°12'E, Indian Ocean, 24 m (13 fms), 19 Nov. 1963, Cr. 4B, st. 225A;

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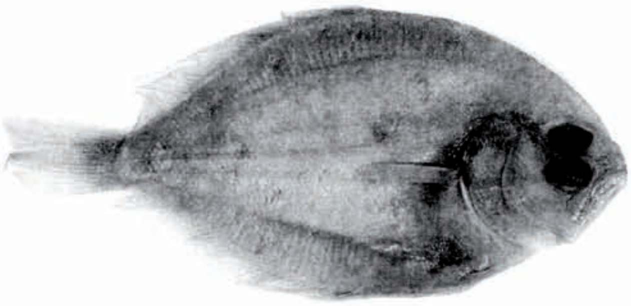

Fig. 1. - Ocular side of a reversed specimen of *Pseudorhombus elevatus*, 103.4 mm SL, collected in the Oman Sea, catalogue number ANSP 145370.

ANSP 145348: 10 spms (84.65-100.42 mm), 22°58'N-67°32'E, Indian Ocean, 28 m (15.5 fms), 19 Nov. 1963, Cr 4B, st. 226A; ANSP 145342: 16 spms (66.36-125.71 mm SL), 21°00'N-91°59'E, Indian Ocean, Bay of Bengal, 23-25 m, 5 Apr. 1963, Cr. 1, st. 46.

Table I. - Measurements and counts of the reversed specimen of *Pseudorhombus elevatus* (ANSP 145370), range for 11 specimens collected at the same station, time and place (ANSP 145325) and for 38 other specimens captured during the same cruise. All specimens examined had 10 precaudal vertebrae.

	Reversed	**ANSP 145325**	**Comparative material**		
		Range	Range	Mean	S. D.
		n = 11	n = 38	n = 49	n = 49
Measurements					
Standard length (SL) (mm)	103.4	81.16-114.48	66.36-137.72	89.36	16.04
In SL					
Body depth	1.77	1.74-1.92	1.70-2.01	1.83	0.08
Head length (HL)	3.18	3.00-3.21	2.87-3.80	3.28	0.19
In HL					
Eyed side maxillary length	2.27	2.25-2.46	2.09-2.68	2.31	0.14
Upper eye diameter	3.93	3.70-4.26	3.34-4.69	3.98	0.28
Eyed side pectoral fin length	1.61	1.58-1.83	1.33-1.98	1.60	0.12
Blind side pectoral fin length	2.22	2.26-2.78	1.98-2.97	2.40	0.19
Counts					
Lateral line scales	67	68-78	63-74	68.39	3.11
Dorsal fin-rays	69	67-70	66-73	69.51	1.56
Anal fin-rays	53	52-56	50-56	53.63	1.24
Caudal fin-rays	17	17	17	17	—
Eyed side pectoral fin-rays	12	11-12	10-13	11.18	0.49
Blind side pectoral fin-rays	10	10-11	8-12	10.27	0.64
Total gill rakers on first branchial arch	14	13-15	11-18	14.43	1.76
Caudal vertebrae	24	23-25	23-25	24.03	0.59

Results and discussion

While examining a collection of fish from the Academy of Natural Sciences of Philadelphia, we found a reversed (dextral) specimen of *P. elevatus* (ANSP 145370) collected in the Oman Sea (20°30'N, 70°54'E, depth 33 m [18 fms], 15 Nov. 1963) (Fig. 1). *P. elevatus* is a tropical species distributed in the Indian Ocean, from Oman Sea and Red Sea to the southernmost tip of Africa (Hensley, 1986). In the Western Pacific, it is found from Taiwan to the northeastern coast of Australia (Nielsen, 1984).

Also, we identified a collection of 11 sinistral specimens of *P. elevatus* collected at the same station and date (ANSP 145325). These specimens and others belonging to the same species collected during the same cruise were used to generate a comparative table of meristic and morphometric values (Table I). Measurements were taken directly on the preserved (70% ethanol) specimens while fin-ray and vertebral counts were made from radiographs.

All characters of the reversed specimen are within the range observed for normal specimens (Table I). Although faded, the typical pigmentation pattern of *P. elevatus* (e.g., five rows of dark rings along the body) is visible on the reversed specimen. Also, as in normal sinistral specimens, the reversed specimen has the tip of the first proximal pterygiophore of the anal fin projecting through the body wall of the blind side, the urinary papilla opening on the eyed side and the anus situated on the blind side. The only discrepancy from an exact mirror image of sinistral specimens lies with the orientation of the intestinal loops and liver which are not reversed in the dextral specimen. However, reversed viscera are extremely rare among reversed specimens (Amaoka, 1964). This specimen represents the first reported case of reversal for *P. elevatus*.

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